BELLCOMM, INC.

SUBJECT: Lunar Surface Coordinate Data for Apollo Guidance Case 340

DATE: May 5, 1967

FROM: D. D. Lloyd

ABSTRACT

A preliminary analysis of Lunar Orbiter Mission II photographs of candidate Apollo sites indicates that the position of lunar surface features can have uncertainties greater than 3 Km. This preliminary result suggests a need for an analysis in greater detail, including a more precise evaluation of all factors that are known to contribute to the uncertainties involved.

The coordinates of the landing sites are needed to target the CSM and to aid recognition of the landing site sighting mark. An estimate of the uncertainty in pre-flight knowledge of landing site position is needed as a guidance software input.

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MEMORANDUM FOR FILE

INTRODUCTION

The present Apollo onboard guidance computer software is designed to process onboard telescope data for orbit determination. Data can be incorporated from other sources including the MSN. Of particular importance to the landing phase are sightings to the landing site sighting mark.

The present guidance software plan includes processing of the data from such a sighting. The plan recognizes that there is pre-flight knowledge of position of the landing site in lunar coordinates and combines this knowledge with the sighting data, making allowances for uncertainties in the data.

Recent Lunar Orbiter photography has indicated significant uncertainties in the positions of lunar surface features. An estimate of the uncertainties is required as an input to the guidance computations.

TECHNICAL DISCUSSION

Lunar Orbiter II photographed thirteen prime sites. Of these, five have been selected as containing candidate Apollo sites for the first Apollo landing. In order to target the CSM, and to reduce the search area for sightings, it is necessary to determine the coordinates of these landing sites.

Attached are charts of Lunar Orbiter sites II-P-2; II-P-6; II-P-8; II-P-11; and II-P-13; showing the picture locations on a coordinate grid. Two alternate methods are used for locating the pictures. Method (a) is by photo matching of Lunar Orbiter photographs to ACIC maps; this map matching is performed by first reducing the Lunar Orbiter photograph to the scale of the ACIC map and then positioning it on the map. Many Lunar Orbiter photographs were map matched by ACIC for the Lunar Orbiter Project Office. The map match data on the attached charts is from this source. Method (b) is from Lunar Orbiter tracking data. The corners of the photographs

are specified as coordinates in the NASA/LRC document LOTD-115-0 (Mission II Photographic Support Data - Final). This document is the final version of Lunar Orbiter Mission II photographic support data, using post flight analysis. Tracking data from two orbits before photography and two orbits after photography are used. The GMT is derived from the onboard clock recorded on the film by timing lights. A nominal spherical moon of 1,738.09 Km radius is used to determine the intersection of the corners of the photographs with the lunar surface.

The attached charts show that there are significant differences in the coordinates obtained for any features dependent upon which method is used. Differences of greater than 3 Km occur for each of the five candidate Apollo areas.

A further analysis of this situation is currently being carried out by the Lunar Orbiter Project Office.

CONCLUSIONS AND RECOMMENDATIONS

The possible effect on the Apollo mission necessitates attention to this subject by many groups at both general and detailed levels. A plan is needed defining the procedure for determining (a) the coordinates of the landing site; and (b) an estimate of the uncertainties in this position data.

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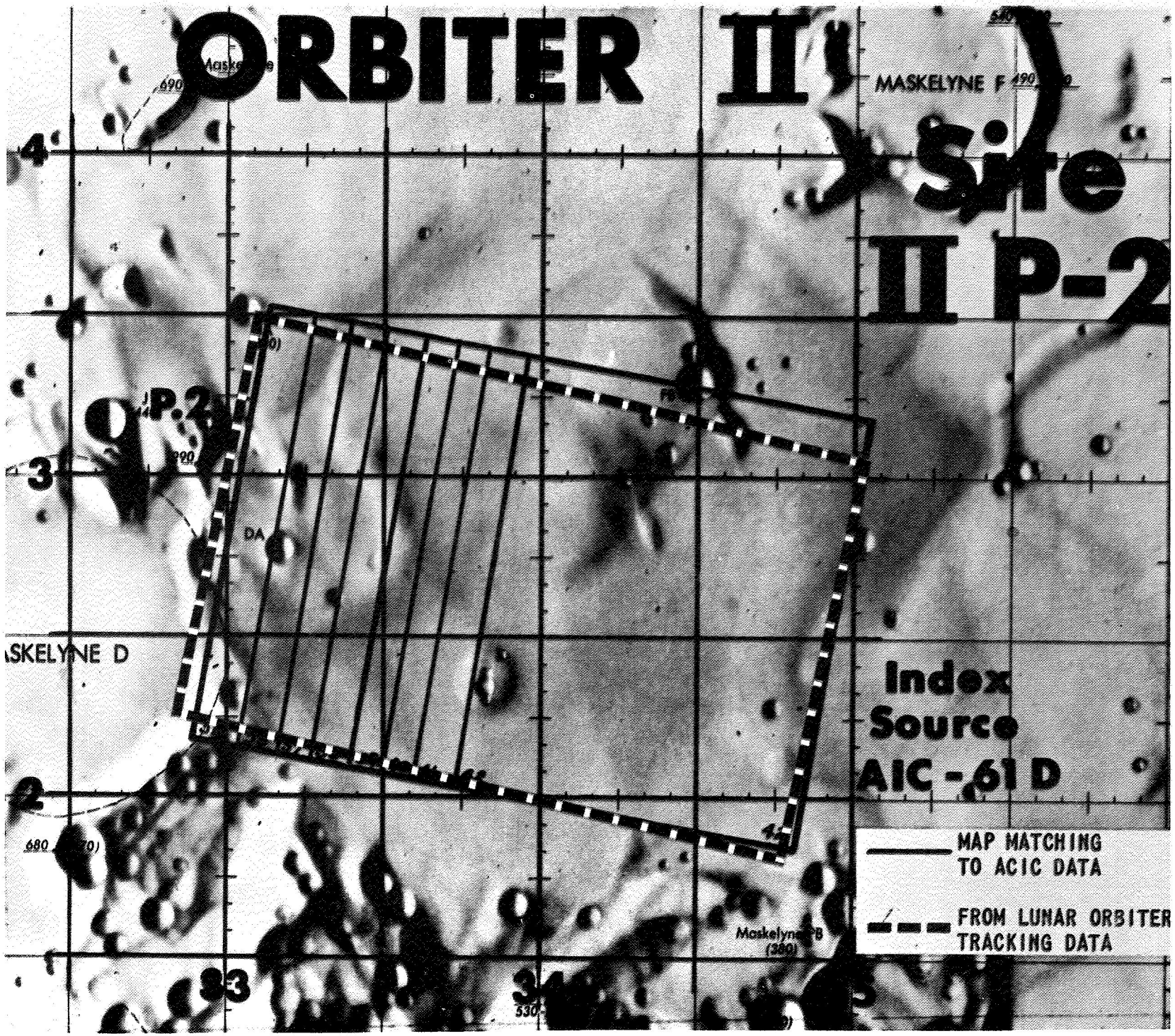
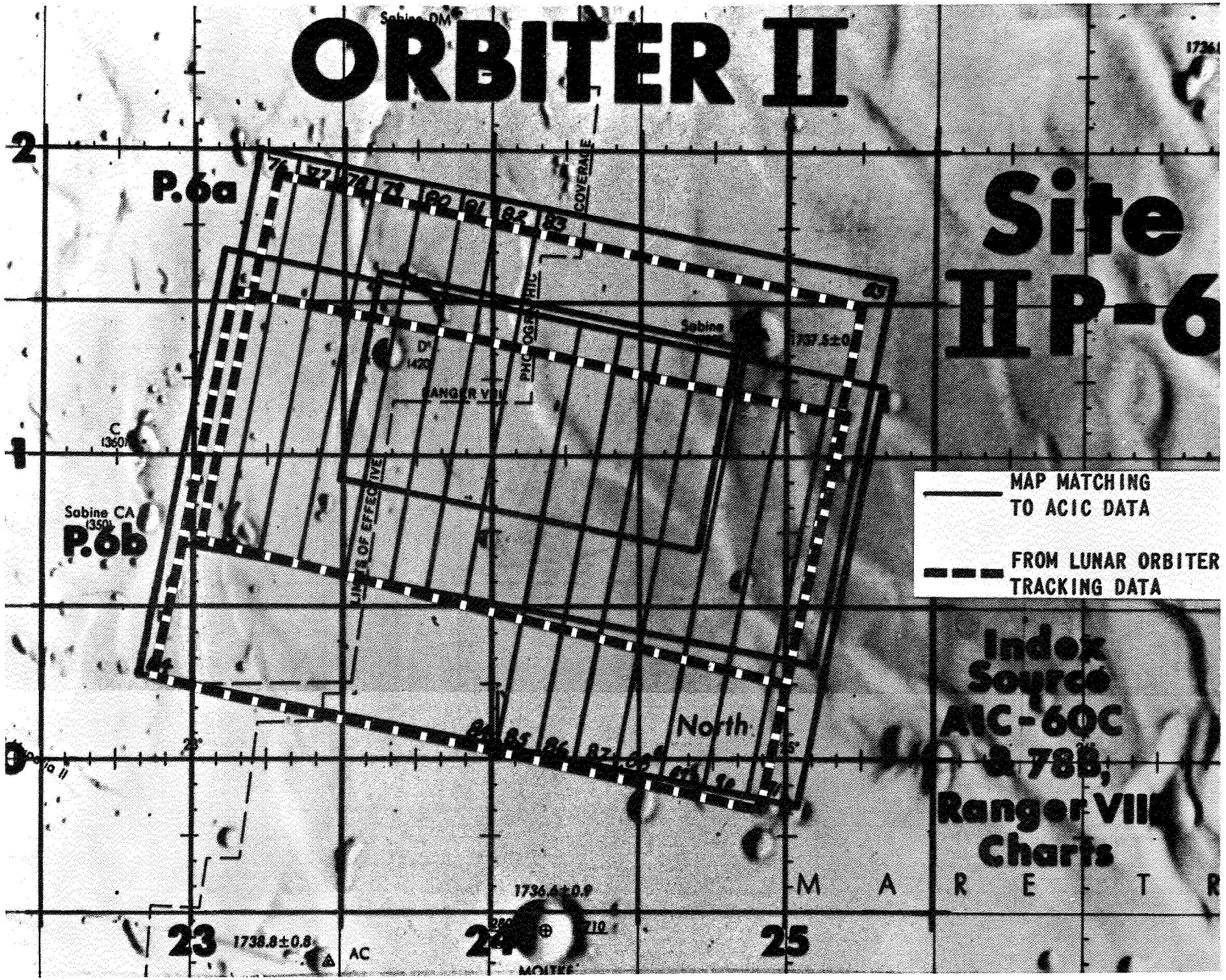
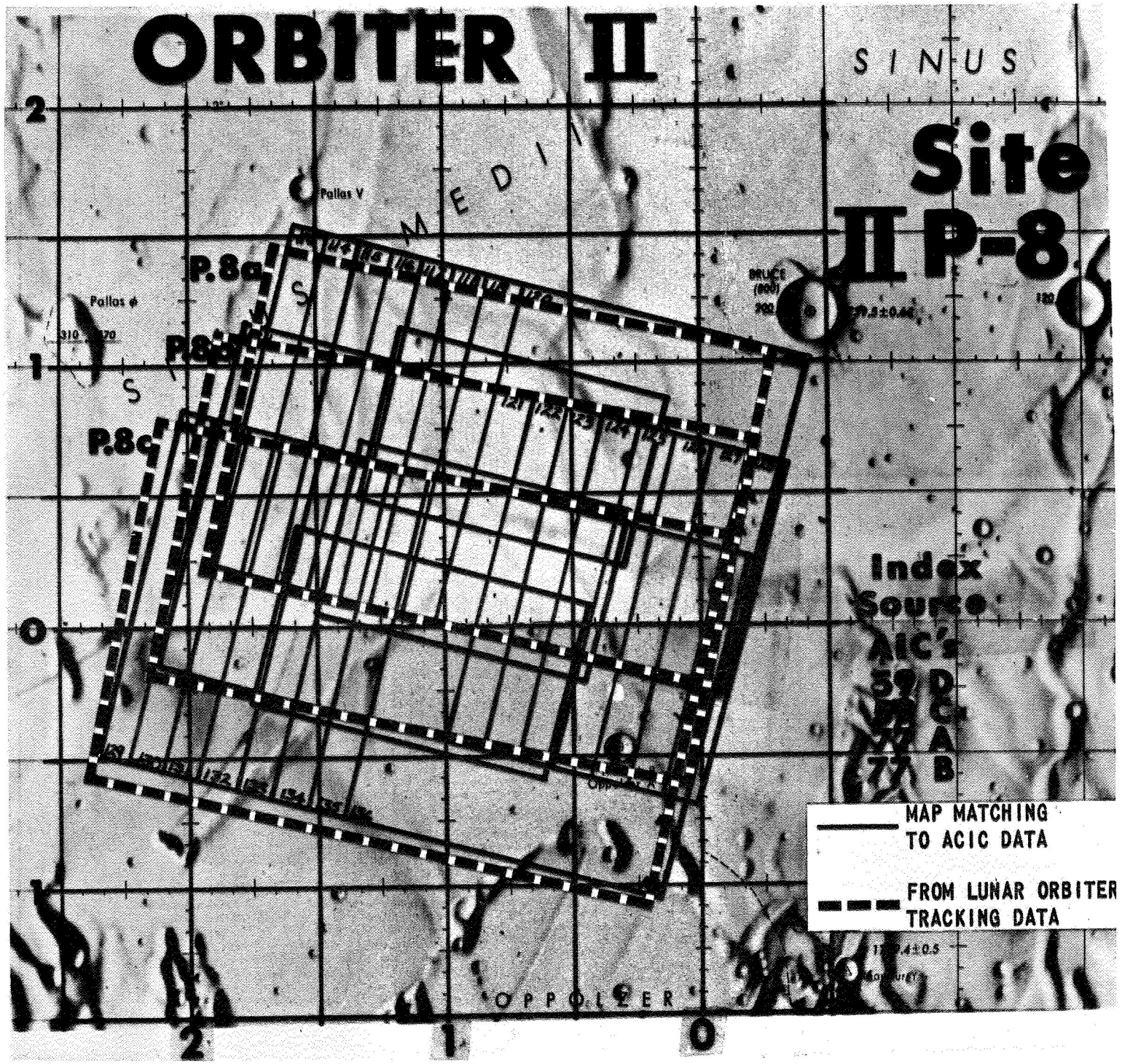
D. D. Lloyd

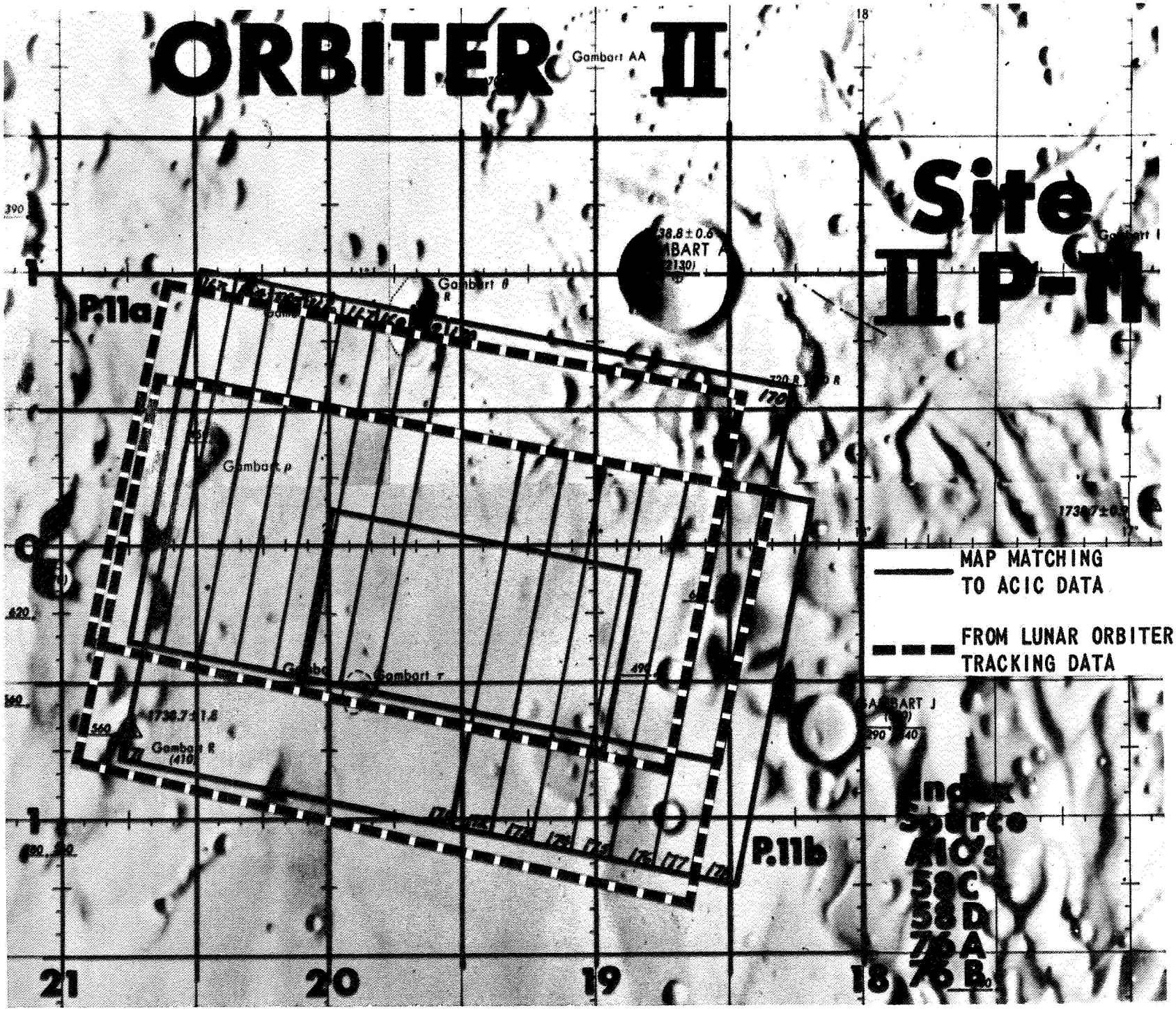
Attachments:
5 charts

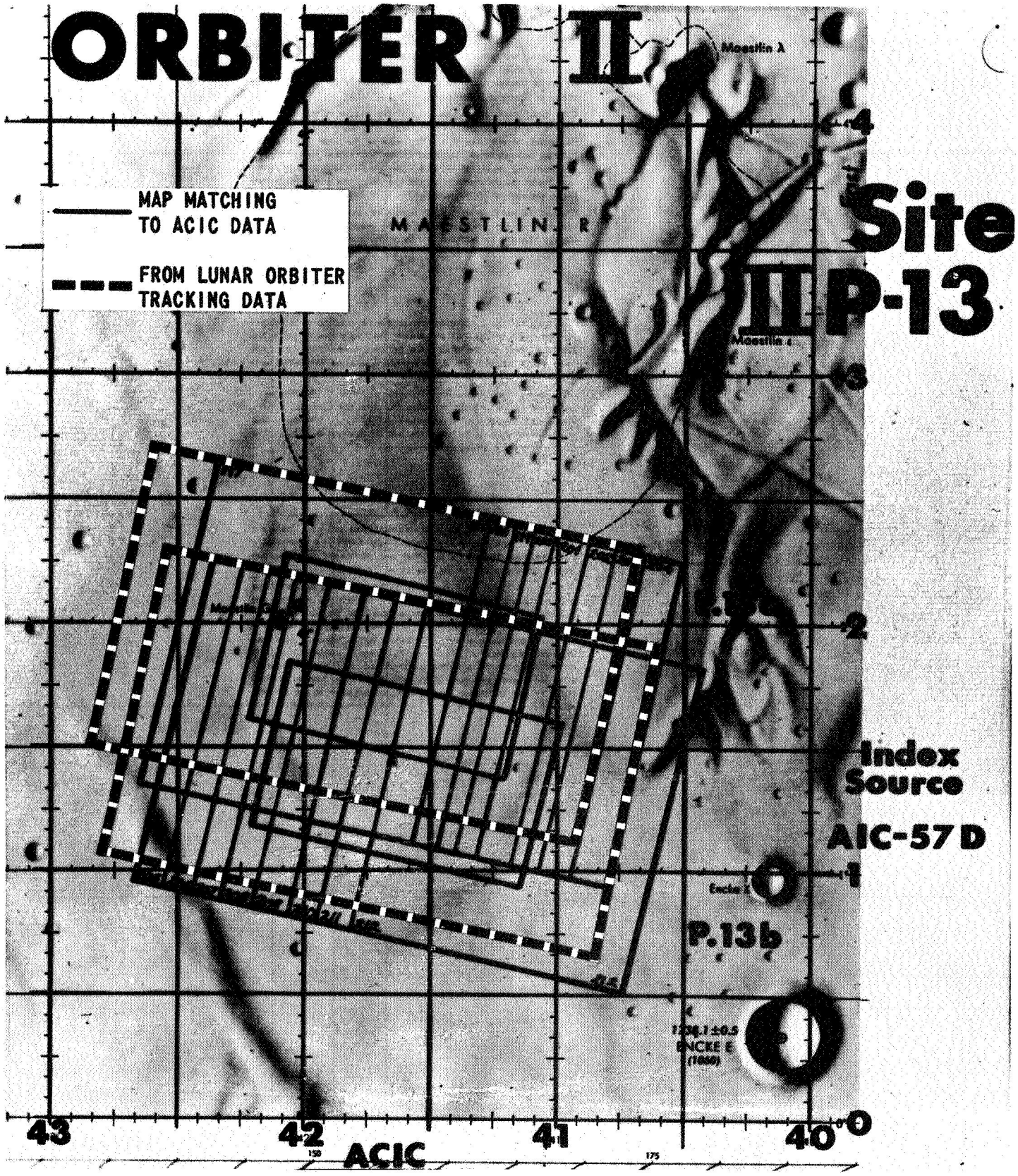
Copy to
Next Page


ORBITER II
Site
II P-2
MASKELYNE F
SKELYNE D
Index
Source
AIC - 61 D
MAP MATCHING
TO ACIC DATA
FROM LUNAR ORBITER
TRACKING DATA


ORBITER II
Site IIP-6
P.6a
P.6b
Sabine CA
Sabine DM
RANGER VIII
LINE OF EFFECTIVE
PHOTOGRAPHIC COVERAGE
MAP MATCHING TO ACIC DATA
FROM LUNAR ORBITER TRACKING DATA
Index Source AIC-60C 3,788; Ranger VIII Charts
North
1737.5±0.
1736.4±0.9
1738.8±0.8
AC
MONTES
M A R E T R
23
24
25


ORBITER II
SINUS
MEDII
Site
II P-8
Pallas V
Pallas
P.8a
P.8b
P.8c
Index
Source
AIC's
MAP MATCHING
TO ACIC DATA
FROM LUNAR ORBITER
TRACKING DATA
OPPOLZER


ORBITER II
Site II P-11
P.11a
P.11b
MAP MATCHING TO ACIC DATA
FROM LUNAR ORBITER TRACKING DATA
Index Sheet
ACICs
58C
58D
76A
76B
Gambart AA
Gambart θ
Gambart ρ
Gambart τ
Gambart J
21
20
19
18


ORBITER II
MAP MATCHING TO ACIC DATA
FROM LUNAR ORBITER TRACKING DATA
MAESTLIN R
Maestlin λ
Maestlin A
Encke E
Site II P-13
Index Source AIC-57D
P.13b
1736.1 ±0.5
ENCKE E
(1686)
43
42
41
40
ACIC